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TRANSMITTAL OF APPEAL BRIEF (Large Entity)	Docket No. END920010002US1

In Re Application Of: **Ray et al.**

Serial No.	Filing Date	Examiner	Group Art Unit
09/779,812	2/8/01	Nguyen, Ha T.	2812

Invention: **LEAD-FREE SOLDER STRUCTURE AND METHOD FOR HIGH FATIGUE LIFE**

TO THE COMMISSIONER FOR PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed on

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DOCKET NO. END920010002US1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ray *et al.*

Examiner: Nguyen, Ha T

Serial No.: 09/779,812

Art Unit: 2812

Filed: 2/08/01

For: **LEAD-FREE SOLDER STRUCTURE AND METHOD FOR HIGH FATIGUE LIFE**

Commissioner for Patents
P.O. Box 1450
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BRIEF OF APPELLANT

This Appeal Brief, pursuant to the Notice of Appeal filed January 6, 2004, is an appeal from the rejection of the Examiner dated September 9, 2003.

REAL PARTY IN INTEREST

International Business Machines, Inc. is the real party in interest.

RELATED APPEALS AND INTERFERENCES

None.

STATUS OF CLAIMS

Claims 1-10 and 12-36 are currently pending. Claims 1-10 and 12-36 have been rejected. This Brief is in support of an appeal from the rejection of claims 1-10 and 12-36.

STATUS OF AMENDMENTS

There are no After-Final Amendments which have not been entered.

SUMMARY OF INVENTION

The present invention discloses an electronic structure and a method for forming the electronic structure. A lead-free solder member is soldered to a first substrate without using a joining solder to effectuate the soldering. The solder member consists essentially of a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight. See specification, page 3, lines 10-18; page 5, lines 8-10; page 9, lines 15-16.

The method may further comprise soldering the solder member to a second substrate with a lead-free joiner solder. See specification, page 7, lines 1-3.

The tin-antimony alloy may include about 5% to about 10% antimony by weight. See specification, page 10, lines 2-3.

The soldering of the solder member to the first substrate may include reflowing the solder member. See specification, page 3, lines 16-18.

The soldering of the solder member to the first substrate may reduce a height of the solder member between about 25% and about 30%. See specification, page 6, lines 9-10.

The first substrate may include a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module. See specification, page 3, lines 12-13.

The first substrate may include a semiconductor chip. See specification, page 16, lines 15-19.

The soldering of the solder member to the second substrate may include reflowing the joiner solder at a temperature above a liquidus temperature of the joiner solder and below a highest temperature which will not damage any portion of the electronic structure. See specification, page 7, lines 11-13; page 9, lines 10-11. See specification, page 7, lines 6-8.

The soldering of the solder member to the second substrate may include reflowing the joiner solder at a temperature below about 250 °C, such as between about 230 °C and about 250 °C. See specification, page 9, lines 11-13.

The joiner solder may consist essentially of a tin-silver-copper alloy, wherein the tin-silver-copper alloy consists essentially of by weight about 95.5-96.0% tin, about 3.5-4.0% silver, and about 0.5-1.0% copper. See specification, page 7, lines 6-8.

The soldering of the solder member to the second substrate may include melting the solder member, which may result in intermixing the tin-antimony alloy with the joiner solder. See specification, page 15, lines 11-21.

The soldering of the solder member to the second substrate may not include melting the solder member, wherein there would be intermixing of the tin-antimony alloy with the joiner solder. See specification, page 15, lines 7-8.

The solder member may be a solder ball. See specification, page 3, lines 10-12.

The tin-antimony alloy may include more than 10% antimony by weight. See specification, page 4, lines 9-22.

ISSUES

1. Whether claims 1-3, 6, 20, 21, 23, 31, 33, 35, and 36 are unpatentable under 35 U.S.C. §103(a) over Yamamoto et al. (EP 0544915 A1, hereinafter "Yamamoto").

2. Whether claim 4 is unpatentable under 35 U.S.C. §103(a) over Yamamoto in view of Gundotra et al. (US Patent 5369880, hereinafter "Gundotra").

3. Whether claims 7-10, 12-19, 24-28, 30, 32, and 34 are unpatentable under 35 U.S.C. §103(a) over Yamamoto, in view of Yamashita et al. (US Patent 6179935, hereinafter "Yamashita").

4. Whether claims 5, 18, 22, and 29 are unpatentable under 35 U.S.C. §103(a) over Yamamoto or Yamamoto and Yamashita, in view of Behlen et al. (US Patent 5598033, hereinafter "Behlen").

GROUPING OF CLAIMS

The claims are grouped as shown in Table 1.

Table 1

Group	Claims	Do Claims of Group Stand or Fall Together?
1	1, 20, 2, 3, 31, 21, 33, 36	Yes
2	6, 23, 19, 30	Yes
3	31, 35	Yes
4	4	Yes
5	7, 24, 8, 9, 16, 17, 25, 27, 34	Yes
6	12, 28	Yes
7	10, 13	Yes
8	14, 15, 26	Yes
9	5, 18, 22, 29	Yes

The claims of Group 2 do not stand and fall together with the claims of Group 1, because the claims of Group 2 include the following issue not present in any of the claims of Group 1: whether the claims of Group 2 are patentable over the cited reference with respect to the feature of "wherein the substrate includes a semiconductor chip".

The claims of Group 3 do not stand and fall together with the claims of Groups 1-2, the claims of Group 3 include the following issue not present in any of the claims of Groups 1-2: whether the claims of Group 3 are patentable over the cited references with respect to the feature of "soldering a lead-free solder member to the substrate ... wherein the solder member is a solder ball".

The claims of Group 4 do not stand and fall together with the claims of Groups 1-3, the claims of Group 4 include the following issue not present in any of the claims of Groups 1-3: whether the claims of Group 4 are patentable over the cited references with respect to the feature of "wherein the soldering step reduces a height of the solder member between about 25% and about 30%".

The claims of Group 5 do not stand and fall together with the claims of Groups 1-4, the claims of Group 5 include the following issue not present in any of the claims of Groups 1-4: whether the claims of Group 5 are patentable over the cited references with respect to the feature of "soldering the solder member to the second substrate with a lead-free joiner solder".

The claims of Group 6 do not stand and fall together with the claims of Groups 1-5, the claims of Group 6 include the following issue not present in any of the claims of Groups 1-5: whether the claims of Group 6 are patentable over the cited references with respect to the feature of "wherein the joiner solder consists essentially of a tin-silver-copper alloy, wherein the tin-silver-copper alloy consists essentially of by weight about 95.5-96.0% tin, about 3.5-4.0% silver, and about 0.5-1.0% copper".

The claims of Group 7 do not stand and fall together with the claims of Groups 1-6, the claims of Group 7 include the following issue not present in any of the claims of Groups 1-6: whether the claims of Group 7 are patentable over the cited references with respect to the feature of "wherein the step of soldering the solder member to the second substrate includes reflowing

the joiner solder at a temperature below about 250 °C [or between about 230 °C and about 250 °C]".

The claims of Group 8 do not stand and fall together with the claims of Groups 1-7, the claims of Group 8 include the following issue not present in any of the claims of Groups 1-7: whether the claims of Group 8 are patentable over the cited references with respect to the features of "wherein the step of soldering the solder member to the second substrate includes melting the solder member" and "wherein the step of soldering the solder member to the second substrate includes intermixing the tin-antimony alloy with the joiner solder".

The claims of Group 9 do not stand and fall together with the claims of Groups 1-8, the claims of Group 9 include the following issue not present in any of the claims of Groups 1-8: whether the claims of Group 9 are patentable over the cited references with respect to the feature of "wherein the substrate includes a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module".

ARGUMENT

Issue 1

CLAIMS 1-3, 6, 20, 21, 23, 31, 33, 35, AND 36 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER YAMAMOTO ET AL. (EP 0544915 A1)

The Examiner rejected claims 1-3, 6, 20, 21, 23, 31, 33, 35, and 36 under 35 U.S.C. §103(a) as allegedly being unpatentable over Yamamoto et al. (EP 0544915 A1, hereinafter "Yamamoto").

Claims 1 and 20

With- respect to claims 1 and 20, the Examiner argues: "Referring to Figs. 4A-8 and related text, discloses Yamamoto discloses a method for forming an electronic structure and inherently the structure formed by the method, the method comprising the steps of providing a substrate 50; and soldering a lead-fee solder member to the substrate without using a joining solder to effectuate the soldering (see page 5, lines 5-14)".

As a first example of why Yamamoto does not teach or suggest each and every feature of claims 1 and 20, Yamamoto does not teach: "soldering a **lead-free** solder member to the substrate without using a joining solder to effectuate the soldering"(claim 1) and "a **lead-free** solder member soldered to the substrate with no joining solder between the solder member and the substrate" (claim 20), (emphasis added).

In response to the preceding argument by the Examiner with respect to the first example of why Yamamoto does not teach or suggest each and every feature of claims 1 and 20,

Appellants respectfully contend that page 5, lines 5-14 of Yamamoto does not teach or suggest that the solder member 56 is lead-free as required by claims 1 and 20. The only required property of the solder member 56 is that the solder member 56 must be a **high-temperature** solder (i.e., the solder has a melting temperature of 240°C - 330°C). See Yamamoto, page 7, line 15. In fact, Yamamoto discloses embodiments in which the high-temperature solder includes substantial amounts of lead (i.e., 85% or more by weight). See Yamamoto, page 7, line 25-26.

Appellants acknowledge that Yamamoto also discloses a high-temperature solder that "**includes** ... Sn-Sb solder **containing** 15% by weight of Sb (antimony) or less" (emphasis added). Yamamoto, page 7, lines 24-27. The use of the open-ended language "includes"conveys an intent not to limit the high-temperature solder to consist of only a Sn-Sb solder; i.e., the "includes" open-ended language expresses an intent to have more than just a Sn-Sb solder in the high-temperature solder, and lead has not been specifically excluded. Moreover, the use of the open-ended language "contains"conveys an intent not to limit the Sn-Sb component of the high-temperature solder to consist of only tin and antimony; i.e., the "contains" open-ended language expresses an intent to include more than just tin and antimony in the Sn-Sb component of the high-temperature solder, and lead has not been specifically excluded. Note that Yamamoto does not state a weight percent of tin in the Sn-Sb solder and Yamamoto does not teach or suggest that the weight percents of tin and antimony add up to 100% or nearly 100%. Also note that Yamamoto specifically teaches use of a high-temperature solder having at least 85% lead by weight (see Yamamoto, page 7, lines 24-27).

Moreover, Yamamoto does not state or suggest anywhere that any of Yamamoto's solders is lead free. Indeed, Yamamoto very specifically identifies a structure as being lead-free

whenever Yamamoto intends such structure to be lead free. For example, Yamamoto identifies part 54 in FIG. 4A as "leadless". S ee Yamamoto, page 5 lines 10-13. Thus, the absence of "leadless" or the like in Yamamoto's description of the high-temperature solder, in stark contrast with Yamamoto's characterization of part 54 as "leadless", makes it clear that Yamamoto is not teaching or suggesting that the high temperature solder is leadless.

Based on the preceding analysis, Appellants respectfully contend that Yamamoto does not teach or suggest that the high temperature solder solder is lead-free. Thus, Appellants assert that Yamamoto does not teach or suggest that the solder member of claims 1 and 20 is lead free. Accordingly, Appellants contend that the Examiner has not established a *prima facie* case of obviousness in relation to claims 1 and 20.

As a second example of why Yamamoto does not teach or suggest each and every feature of claims 1 and 20, Yamamoto does not teach or suggest "wherein the solder member **consists essentially of** a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight" (emphasis added).

The Examiner argues: "Referring to Figs. 4A-8 and related text, ... the solder member consists essentially a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 15% antimony by weight or less and a remainder consisting essentially of tin by weight (See page 7, lines 24-28)."

In response to the preceding argument by the Examiner, Appellants respectfully contend that the exact language in page 7, lines 24-28 of Yamamoto is: "The high-temperature solder

used in the present invention **includes** ... Sn-Sb solder **containing** 15% by weight of Sb (antimony) or less" (emphasis added). Appellants contend that Yamamoto uses the open-ended word "includes", which does not satisfy the more limiting language of "consists essentially of" in the feature "wherein the solder member consists essentially of a tin-antimony alloy" in claims 1 and 20. Appellants further contend that Yamamoto uses the open-ended word "containing" which does not satisfy the more limiting language of "consisting essentially of" in the feature "wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight" in claims 1 and 20. See MPEP 2111.03, which states:

> "The transitional term "comprising", which is synonymous with "including," "containing," or "characterized by," is inclusive or open-ended and does not exclude additional, unrecited elements or method steps. See, e.g., *Genentech, Inc. v. Chiron Corp.*, 112 F.3d 495, 501, 42 USPQ2d 1608, 1613 (Fed. Cir. 1997) ("Comprising" is a term of art used in claim language which means that the named elements are essential, but other elements may be added and still form a construct within the scope of the claim.); *Moleculon Research Corp. v. CBS, Inc.*, 793 F.2d 1261, 229 USPQ 805 (Fed. Cir. 1986); *In re Baxter*, 656 F.2d 679, 686, 210 USPQ 795, 803 (CCPA 1981); *Ex parte Davis*, 80 USPQ 448, 450 (Bd. App. 1948) ("comprising" leaves "the claim open for the inclusion of unspecified ingredients even in major amounts")."

The meaning of "consisting essentially of" is defined in MPEP 2111.03 which states: "The transitional phrase "consisting essentially of" limits the scope of a claim to the specified materials or steps "and those that do not materially affect the basic and novel characteristic(s)" of the claimed invention (citing *In re Her*, 537 F.2d 549, 551-52, 190 USPQ 461, 463 (CCPA 1976)).

In "Response to Amendment", the Examiner argues that "the use of "consists essentially" allows for the inclusion of additional materials that do not materially affect the basic and novel

characteristics. In Yamamoto the solder is Sn-Sb, this implies that any additional material included in the Sn-Sb solder would not materially affect the basic and novel characteristic of Sn-Sb.... [The] basic characteristic (functions as a solder) and the novel characteristic (lead free) of the disclosed Sn-Sb solder are not effected by additions of other materials. ... 'Applicant has the burden of showing that the introduction of additional steps or components would materially change the characteristics of applicant's invention'. Besides, 'For the purposes of searching for and applying prior art under 35 U.S.C. 102 and 103, absent a clear indication in the specification or claims of what the basic and novel characteristics actually are, "consisting essentially of" will be construed as equivalent to "comprising." (See MPEP 2111.03)."

In light of the preceding quotation from MPEP 2111.03 cited by the Examiner, Appellants next establish from Appellants' specification that "the introduction of additional steps or components would materially change the basic and novel characteristics of Appellants's invention", so that "consisting essentially of" will not be construed as equivalent to "comprising" in claims 1 and 20. The basic and novel characteristic at issue is absence of toxicity in the solder member of claims 1 and 20, as will be explained next.

The specification states that "[t]he present invention provides a **lead-free** solder interconnect structure for reliably coupling an electronic module to a circuit card" (emphasis added) (see specification, page 2, lines 20-21), and that "[u] nfortunately, **lead is toxic and environmentally hazardous**" (emphasis added) (see specification, page 2, lines 20-21). The specification further states that "[i]t should be noted that **antimony trioxide is toxic**. Thus, the presence of antimony in the tin-antimony alloy used in the solder ball **16** would be a health concern if antimony trioxide had a propensity to form in conjunction with fabricating the

electronic structure **10**. Nonetheless, antimony is not oxidized to form antimony trioxide at a temperature less than about 550 °C. In a worst-case using a tin-antimony alloy having 15% antimony by weight, the temperature required to reflow the tin-antimony alloy in the solder ball **16** need not exceed 300 °C even if the reflow occurs at 20 °C above the liquidus temperature 280 °C. Thus, the use of antimony in the tin-antimony alloy of the solder ball **16** poses essentially no risk of forming antimony trioxide during the soldering of the solder ball **16** to the electronic module **12**" (emphasis added) (see specification, page 4, line 23 - page 5, line 7).

Thus, Appellants maintain that an introduction of a toxic ingredient (i.e., lead, antimony oxide, etc.) into the solder member of claims 1 and 20 would materially affect the basic and novel characteristics of the claimed invention. Based on analysis of the preceding citations from the specification, Appellants have met Appellants' burden to prove that a clear indication exists in the specification of what the basic and novel characteristics actually are. The basic and novel characteristics are absence of toxicity, and an introduction of a toxic constituent into the solder member would therefore materially affect the basic and novel characteristics of the claimed invention. Thus, Appellants maintain that "consisting essentially of" is not to be construed as equivalent to "comprising" in claims 1 and 20. As explained *supra*, Yamamoto does not teach or suggest that Yamamoto's solder member "**consists essentially of** a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight" (emphasis added). Accordingly, Appellants contend that claims 1 and 20 are not unpatentable over Yamamoto.

Based on the preceding arguments, Appellants respectfully maintain that claims 1 and 20 are not unpatentable over Yamamoto, and that claims 1 and 20 are in condition for allowance.

Claims 2, 3, and 35

Since claims 2, 3, and 35 depend from claim 1 which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 2, 3, and 35 are patentable under 35 U.S.C. §103(a).

Claims 21, 33, and 36

Since claims 21, 33, and 36 depend from claim 20 which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 21, 33, and 36 are patentable under 35 U.S.C. §103(a).

Claims 6 and 23

Since claims 6 and 23 depend from claim 1 and 20, respectively, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 3 and 23 are patentable under 35 U.S.C. §103(a).

Additionally as to claims 6 and 23, Appellants maintain that Yamamoto does not disclose the feature: "wherein the substrate includes a semiconductor chip". The Examiner alleges that Yamamoto discloses on page 7, lines 10-17 that the substrate includes a semiconductor chip. In response, Appellants note that Yamamoto, page 7, lines 10-17 discloses only that the substrate includes semiconductor elements. A semiconductor element is not necessarily a semiconductor chip. For example, the semiconductor elements disclosed by Yamamoto may be no more than silicon regions, which are not semiconductor chips. Note that a semiconductor chip is a "single substrate on which all the active and passive circuit elements have been fabricated using one or

all of the semiconductor techniques of diffusion, passivation, masking, photoresist, and epitaxial growth. See Modern Dictionary of Electronics 154 (6th ed. 1997). In addition, the Examiner has provided no analysis at all in support of any contention that page 7, lines 10-17 suggests a semiconductor chip. Thus, Appellants contend that the Examiner's argument is not persuasive in relation to claims 6 and 23, and the Examiner has not satisfied the Examiner's burden to prove a *prima facie* case of obviousness in relation to claims 6 and 23.

Claim 31

Since claim 31 depends from claim 1, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 31 is patentable under 35 U.S.C. §103(a).

Additionally as to claim 31 which claims "soldering a lead-free solder member to the substrate ... wherein the solder member is a solder ball", Appellants contend that Yamamoto does not disclose a process capable of soldering a solder ball to the substrate. On page 11, lines 1-19, Yamamoto discloses two alternative processes for forming the solder projection 56. The first process for forming the solder projection 56 uses a flow method deposit high-temperature molten solder on the substrate to subsequently form the solder projection 56. In said flow method, no solder ball is soldered to the substrate since no solder member exists until after all of the molten solder has been deposited on the substrate, i.e., the shapeless molten solder being deposited on the substrate is does not have the geometry of a solder ball. Note that the language of claim 1 (from which claim 31 depends) requires that the solder ball exist prior to the soldering

of the solder ball to the substrate; i.e., it is physically impossible to solder a non-existent solder ball to a substrate.

The second process for forming the solder projection 56 uses a reflow method in which solder paste is screened or dispensed onto the substrate and then reflowed to subsequently form the solder projection 56. In order to satisfy claim 31, the solder paste on the substrate prior to being reflowed would have to be construed as a solder ball. Appellants contend that said solder paste is a blob of solder paste which cannot be construed as having the geometry of a solder ball. Therefore, if the blob of solder paste on the substrate is not a solder ball, then it follows that said reflow method of Yamamoto does not solder a solder ball to the substrate, as required by claim 1.

The Examiner refers to FIGS. 4A-12 of Yamamoto as allegedly disclosing the solder member as a solder ball. Appellants contend, however, that FIGS. 4A-12 of Yamamoto show the projection 56 after being formed on the substrate 50. Prior to being formed as a solder ball, either molten solder is deposited on the substrate (which does not have the geometrical shape of a solder ball and which does not constitute soldering a solder ball to the substrate) or a blob of solder is screened or dispensed to the substrate 50, and the blob of solder does not have the geometrical shape of a solder ball. Thus, Yamamoto's flow and reflow processes is incapable of soldering a solder ball to the substrate, since no solder ball exists prior to or during the flow process or reflow process. The solder ball in FIGS. 4A-12 of Yamamoto exists only after the flow or reflow process has been completed. Thus, Appellants respectfully contend that claim 31 is not obvious over Yamamoto.

Issue 2

CLAIM 4 IS NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER YAMAMOTO IN VIEW OF GUNDOTRA ET AL. (US PATENT 5369880)

The Examiner rejected claim 4 under 35 U.S.C. §103(a) as allegedly being unpatentable over Yamamoto in view of Gundotra et al. (US Patent 5369880, hereinafter "Gundotra").

Since claim 4 depends from claim 1, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 4 is patentable under 35 U.S.C. §103(a).

Additionally, Appellants respectfully contend that Yamamoto in view of Gundotra does not teach or suggest the feature: "wherein the soldering step reduces a height of the solder member between about 25% and about 30%".

The Examiner admits that Yamamoto does not disclose the preceding feature of claim 4. The Examiner alleges that Gundotra disclose the preceding feature of claim 4. The Examiner argues: "A person of ordinary skill is motivated to modify Yamamoto with Gundotra to obtain the desired height reduction appropriate for a specific application."

In response, Appellants respectfully contend that the preceding argument by the Examiner is vague and indefinite and thus not persuasive. The Examiner has not provided any unambiguous reason why one of ordinary skill in the art would find it obvious to modify Yamamoto's invention by Gundotra's teaching. Accordingly, Appellants contend that the Examiner has not established a *prima facie* case of obviousness in relation to claim 4.

Issue 3

CLAIMS 7-10, 12-19, 24-28, 30, 32, AND 34 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER YAMAMOTO, IN VIEW OF YAMASHITA ET AL. (US PATENT 6179935).

The Examiner rejected claims 7-10, 12-19, 24-28, 30, 32, and 34 under 35 U.S.C. §103(a) as allegedly being unpatentable over Yamamoto, in view of Yamashita et al. (US Patent 6179935, hereinafter "Yamashita").

Claims 7 and 24

Appellants respectfully contend that claims 7 and 24 are not unpatentable over Yamamoto in view of Yamashita,

based on the same arguments presented *supra* in relation to claims 1 and 20.

In addition with respect to claims 7 and 24, Appellants contend that Yamamoto in view of Yamashita does not teach or suggest the feature: "soldering the solder member to the second substrate with a **lead-free joiner solder**" (claim 7) and "wherein the solder member is soldered to the second substrate with a **lead-free joiner solder**" (claim 24), (emphasis added)..

The Examiner admits that the joiner compound that solders the solder member to the second substrate is not lead-free. The Examiner alleges that Yamashita discloses a lead-free joiner compound in the paragraph bridging columns 9 and 10. The Examiner argues: "A person of ordinary skill is motivated to modify Yamamoto with Yamashita to obtain the connection of desired characteristics appropriate for a specific application."

In response, Appellants respectfully contend that the preceding argument by the Examiner

is vague and indefinite and thus not persuasive. The Examiner has not provided any unambiguous reason why one of ordinary skill in the art would find it obvious to modify Yamamoto's invention by Gundotra's teaching of the lead-free alloy. In fact, Yamamoto teaches away from use of said lead-free joiner compound by requiring "regular solder (60 Sn/40Pb solder having a melting point of 183° - 188°C)" which contains 40% lead. Accordingly, Appellants contend that the Examiner has not established a *prima facie* case of obviousness in relation to claims 7 and 24.

Based on the preceding arguments, Appellants respectfully maintain that claims 7 and 24 are not unpatentable over Yamamoto in view of Yamashita, and that claims 7 and 24 are in condition for allowance.

Claims 8-9 and 16-17

Since claims 8-9 and 16-17 depend from claim 7 which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 8-9 and 16-17 are patentable under 35 U.S.C. §103(a).

Claims 25, 27, and 34

Since claims 25, 27, and 34 depend from claim 24 which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 25, 27, and 34 are patentable under 35 U.S.C. §103(a).

Claims 12 and 28

Since claims 12 and 28 depend from claims 7 and 24, respectively, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 12 and 28 are patentable under 35 U.S.C. §103(a).

Additionally with respect to claims 12 and 28, Appellants respectfully maintain that Yamamoto in view of Yamashita does not teach or suggest the feature: "wherein the joiner solder consists essentially of a tin-silver-copper alloy, wherein the tin-silver-copper alloy consists essentially of by weight about 95.5-96.0% tin, about 3.5-4.0% silver, and about 0.5-1.0% copper." The Examiner alleges that Yamashita discloses the preceding feature in the paragraph bridging columns 9 and 10. The Examiner argues: "A person of ordinary skill is motivated to modify Yamamoto with Yamashita to obtain the connection of desired characteristics appropriate for a specific application."

In response, Appellants respectfully contend that Yamashita does not satisfy the preceding feature, because the paragraph bridging columns 9 and 10 of Yamashita does not disclose that the tin-silver-copper-nickel-germanium-phosphorus alloy includes 95.5%-96.0% tin. Also, the paragraph bridging columns 9 and 10 of Yamashita does not disclose the "consists essentially of" language of claims 12 and 28, since Yamashita's alloy includes Ni, Ge, and P in addition to tin, silver, and copper.

In addition, the preceding argument by the Examiner in relation to claims 12 and 28 is vague and indefinite and thus not persuasive. The Examiner has not provided any unambiguous reason why one of ordinary skill in the art would find it obvious to modify Yamamoto's invention by Gundotra's teaching of the tin-silver-copper-nickel-germanium-phosphorus alloy .

In fact, Yamamoto teaches away from use of said tin-silver-copper-nickel-germanium-phosphorus joiner compound by requiring "regular solder (60 Sn/40Pb solder having a melting point of 183° - 188°C)". Accordingly, Appellants contend that the Examiner has not established a *prima facie* case of obviousness in relation to claims 12 and 28.

Claim 18

Since claim 18 depends from claim 7, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 18 is patentable under 35 U.S.C. §103(a).

Additionally, the Examiner has not provided any argument to support the rejection of claim 18 over Yamamoto in view of Yamashita. Therefore, the rejection of claim 18 over Yamamoto in view of Yamashitan is improper.

Claim 10

Since claim 10 depends from claim 7, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 10 is patentable under 35 U.S.C. §103(a).

Additionally, with respect to claim 10, Appellants respectfully maintain that Yamamoto in view of Yamashita does not teach or suggest the feature: "wherein the step of soldering the solder member to the second substrate includes reflowing the joiner solder at a temperature ... below about 250 °C". Although the Examiner alleges that the preceding feature of claim 10 is disclosed on page 11, lines 14-31 of Yamamoto, Appellants contend that there the page 11, lines

14-31 of Yamamoto proves just the opposite. Indeed, page 11, lines 24-26 of Yamamoto recite that the joiner solder is "heated to temperature ... lower than that of the high-temperature solder." However, page 7, line 15 of Yamamoto states that the "high-temperature solder [has] a melting point of 240° - 330°C ...." Thus, Yamamoto clearly excludes a temperature of 240 °C or more for the joiner solder and thus specifically excludes, the temperature range of from 240 °C to below 250 °C for the joiner solder. Therefore, Yamamoto, does not teach or suggest the preceding feature of claim 10.. Accordingly, Appellants contend that claim 10 is not unpatentable over Yamamoto in view of Yamashita.

Claim 13

Since claim 13 depends from claim 7, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 13 is patentable under 35 U.S.C. §103(a).

Additionally, with respect to claim 13, Appellants respectfully maintain that Yamamoto in view of Yamashita does not teach or suggest the feature: "wherein the step of soldering the solder member to the second substrate includes reflowing the joiner solder at a temperature between about 230 °C and about 250 °C". Although the Examiner alleges that the preceding feature of claim 10 is disclosed on page 11, lines 14-31 of Yamamoto, Appellants contend that there the page 11, lines 14-31 of Yamamoto proves just the opposite. Indeed, page 11, lines 24-26 of Yamamoto recite that the joiner solder is "heated to temperature ... lower than that of the high-temperature solder." However, page 7, line 15 of Yamamoto states that the "high-

temperature solder [has] a melting point of 240° - 330°C ...." Thus, Yamamoto clearly excludes a temperature of 240 °C or more for the joiner solder and thus specifically excludes, the temperature range of from 240 °C to below 250 °C for the joiner solder. Therefore, Yamamoto, does not teach or suggest the preceding feature of claim 13. Accordingly, Appellants contend that claim 13 is not unpatentable over Yamamoto in view of Yamashita.

Claims 19 and 30

Since claims 19 and 30 depend from claims 7 and 24, respectively, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 19 and 30 are patentable under 35 U.S.C. §103(a).

In addition with respect to claims 19 and 30, Appellants respectfully maintain that Yamamoto in view of Yamashita does not teach or suggest the feature: "wherein the first substrate includes a semiconductor chip", based on the same reasons presented *supra* in relation to claims 6 and 23.

Claims 14, 15 and 26

Since claims 14, 15 and 26 depend from claims 7, 7, and 24, respectively, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claims 14, 15, and 26 are patentable under 35 U.S.C. §103(a).

In addition claims 14, 15, and 26 recite the features: "wherein the step of soldering the solder member to the second substrate includes melting the solder member" (claim 14), "wherein the step of soldering the solder member to the second substrate includes intermixing the tin-

antimony alloy with the joiner solder" (claim 15); and "wherein the tin-antimony alloy is intermixed with the joiner solder" (claim 26). Appellants contend, however, that the preceding features cannot be incorporated into Yamamoto, because Yamamoto requires a high-temperature solder that is not melted and is thus not intermixed with the joiner compound when the solder member is soldered to the second substrate. See Yamamoto, col 11, lines 21-26; col. 13 lines 1-5 (i.e., claim 15); col. 5, lines 15-16. Indeed, Yamamoto explains in page 5, lines 14-24 why the high-temperature solder is not melted and is thus not intermixed with the joiner compound when the solder member is soldered to the second substrate. Accordingly, Appellants contend that claims 14-15 and 26 are not unpatentable over Yamamoto in view of Yamashita.

Claim 32

Since claim 32 depend from claim 7 which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 7 is patentable under 35 U.S.C. §103(a).

In addition with respect to claim 7, Appellants respectfully maintain that Yamamoto in view of Yamashita does not teach or suggest the feature: "soldering a lead-free solder member to the first substrate ... wherein the solder member is a solder ball", based on the same reasons presented *supra* in relation to claim 31.

Issue 4

CLAIMS 5, 18, 22, AND 29 ARE NOT UNPATENTABLE UNDER 35 U.S.C. §103(A) OVER YAMAMOTO OR YAMAMOTO AND YAMASHITA, IN VIEW OF BEHLEN ET AL. (US PATENT 5598033).

The Examiner rejected claims 5, 18, 22, and 29 under 35 U.S.C. §103(a) as allegedly being unpatentable over Yamamoto or Yamamoto and Yamashita, in view of Behlen et al. (US Patent 5598033, hereinafter "Behlen").

Since claim 5 depend from claim 1, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 5 is not unpatentable under 35 U.S.C. §103(a).

Since claim 18 depend from claim 7, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 18 is not unpatentable under 35 U.S.C. §103(a).

Since claim 22 depend from claim 20, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 20 is not unpatentable under 35 U.S.C. §103(a).

Since claim 29 depend from claim 24, which Appellants have argued *supra* to be patentable under 35 U.S.C. §103(a), Appellants maintain that claim 29 is not unpatentable under 35 U.S.C. §103(a).

In addition, the Examiner alleges that "Behlen discloses CBGA and PGCA are common type of electronic package". The Examiner argues: "A person of ordinary skill is motivated to modify Yamamoto or Yamamoto and Yamashita with Behlen to obtain the desired package

appropriate for a specific application. Therefore, it would have been obvious to combine Yamamoto or Yamamoto and Yamashita with Behlen to obtain the invention as specified in claims 5, 18, 22, and 29."

In response, Appellants respectfully contend that the preceding argument by the Examiner is vague and indefinite and thus not persuasive. The Examiner has not provided any unambiguous reason why one of ordinary skill in the art would find it obvious to modify Yamamoto or Yamamoto and Yamashita with Behlen. Accordingly, Appellants contend that the Examiner has not established a *prima facie* case of obviousness in relation to claims 5, 18, 22, and 29.

SUMMARY

In summary, Appellant respectfully requests reversal of the September 9, 2003 Office Action rejection of claims 1-10 and 12-36.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ray *et al.* Examiner: Nguyen, Ha T

Serial No.: 09/779,812 Art Unit: 2812

Filed: 2/08/01

For: **LEAD-FREE SOLDER STRUCTURE AND METHOD FOR HIGH FATIGUE LIFE**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPENDIX - CLAIMS ON APPEAL

1. A method for forming an electronic structure, comprising the steps of:

providing a substrate; and

soldering a lead-free solder member to the substrate without using a joining solder to effectuate the soldering, wherein the solder member consists essentially of a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight.

2. The method of claim 1, wherein the tin-antimony alloy includes about 5% to about 10% antimony by weight.

3. The method of claim 1, wherein the soldering step includes reflowing the solder member.

4. The method of claim 1, wherein the soldering step reduces a height of the solder member between about 25% and about 30%.

5. The method of claim 1, wherein the substrate includes a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module.

6. The method of claim 1, wherein the substrate includes a semiconductor chip.

7. A method for forming an electronic structure, comprising the steps of:

providing a first substrate and a second substrate;

soldering a lead-free solder member to the first substrate without using a joining solder to effectuate the soldering, wherein the solder member consists essentially of a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight; and

soldering the solder member to the second substrate with a lead-free joiner solder.

8. The method of claim 7, wherein the tin-antimony alloy includes about 5% to about 10% antimony by weight.

9. The method of claim 7, wherein the step of soldering the solder member to the second substrate includes reflowing the joiner solder at a temperature above a liquidus temperature of the joiner solder and below a highest temperature which will not damage any portion of the

electronic structure.

10. The method of claim 7, wherein the step of soldering the solder member to the second substrate includes reflowing the joiner solder at a temperature above a liquidus temperature of the joiner solder and below about 250 °C.

12. The method of claim 7, wherein the joiner solder consists essentially of a tin-silver-copper alloy, wherein the tin-silver-copper alloy consists essentially of by weight about 95.5-96.0% tin, about 3.5-4.0% silver, and about 0.5-1.0% copper.

13. The method of claim 12, wherein the step of soldering the solder member to the second substrate includes reflowing the joiner solder at a temperature between about 230 °C and about 250 °C.

14. The method of claim 7, wherein the step of soldering the solder member to the second substrate includes melting the solder member.

15. The method of claim 14, wherein the step of soldering the solder member to the second substrate includes intermixing the tin-antimony alloy with the joiner solder.

16. The method of claim 7, wherein the step of soldering the solder member to the second substrate does not include melting the solder member.

17. The method of claim 16, wherein the step of soldering the solder member to the second substrate does not include intermixing the tin-antimony alloy with the joiner solder.

18. The method of claim 7, wherein the first substrate includes a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module.

19. The method of claim 7, wherein the first substrate includes a semiconductor chip.

20. An electronic structure, comprising:

a substrate;

a lead-free solder member soldered to the substrate with no joining solder between the solder member and the substrate, wherein the solder member consists essentially of a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight.

21. The electronic structure of claim 20, wherein the tin-antimony alloy includes about 5% to about 10% antimony by weight.

22. The electronic structure of claim 20, wherein the substrate includes a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module.

23. The electronic structure of claim 20, wherein the substrate includes a semiconductor chip.

24. An electronic structure, comprising:

a first substrate;

a second substrate; and

a lead-free solder member soldered to the first substrate with no joining solder between the solder member and the first substrate, wherein the solder member is soldered to the second substrate with a lead-free joiner solder, wherein the solder member consists essentially of a tin-antimony alloy, and wherein the tin-antimony alloy consists of about 3% to about 15% antimony by weight and a remainder consisting essentially of tin by weight.

25. The electronic structure of claim 24, wherein the tin-antimony alloy includes about 5% to about 10% antimony by weight.

26. The electronic structure of claim 24, wherein the tin-antimony alloy is intermixed with the joiner solder.

27. The electronic structure of claim 24, wherein the tin-antimony alloy is not intermixed with the joiner solder.

28. The electronic structure of claim 24, wherein the joiner solder consists essentially of a tin-silver-copper alloy, wherein the tin-silver-copper alloy consists essentially of by weight about 95.5-96.0% tin, about 3.5-4.0% silver, and about 0.5-1.0% copper.

29. The electronic structure of claim 24, wherein the first substrate includes a ceramic ball grid array (CBGA) module or a plastic ball grid array (PBGA) module.

30. The electronic structure of claim 24, wherein the first substrate includes a semiconductor chip.

31. The method of claim 1, wherein the solder member is a solder ball.

32. The method of claim 7, wherein the solder member is a solder ball.

33. The method of claim 20, wherein the solder member is a solder ball.

34. The method of claim 24, wherein the solder member is a solder ball.

35. The method of claim 1, wherein the tin-antimony alloy includes more than 10% antimony by weight.

36. The method of claim 20, wherein the tin-antimony alloy includes more than 10% antimony by weight.